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ABSTRACT

Dynamic visual acuity (DVA) is defined as the performer's ability to visually discriminate parts of an object when there is relative motion between the target and the performer. According to research findings, this visual attribute may play a key role in motor-task performance. Researchers have found a significant relationship between DVA and performance on a ball catching task. Other factors contributing to skilled motor performance are depth perception and peripheral vision. It has been found that skilled athletes possess a more efficient visual system than nonathletes. Information obtained from visual screening may help teachers and coaches identify causes of poor motor performance, and, once the causes of poor performance have been identified, corrective measures may be taken. Because of the heavy demands placed on the visual systems of athletes, visual screening should have a greater role in predicting future performance, providing better individualized instruction, and finding better means of correcting faulty performance. (JD)

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WHAT RESEARCH SAYS ABOUT:

Visual Attributes and Skilled Motor Performance

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WHAT RESEARCH SAYS ABOUT:

Visual Attributes and Skilled Motor Performance

Assessing physical characteristics of athletes and other individuals attempting to learn motor skills has long been a major concern of teachers and coaches. For the most part the parameters assessed have included cardio-vascular endurance, strength, speed, and flexibility. No doubt the aforementioned parameters are important attributes for success in athletic contest, however, they all have one thing in common; they are generally evaluated on the final out come of task performance (end product of overt movement). For example, the batter in baseball who consistently swings late at the pitched ball is generally instructed to choke up on the bat or improve arm and wrist strength so that the swing can be accomplished in a shorter period of time. Unfortunately several important concepts have been overlooked. That being the information processing which must occur prior to overt movement. Before one proceeds with meaningful movement, stimulus information must be gathered from the environment (input) and processed by the central nervous system (information processing). In an attempt to correct poor performance it appears that many coaches and teachers immediately employ corrective techniques involving adjustments in overt movement patterns, when in fact the undesirable movement may be caused by a breakdown in one of the other two processes (input, central processing). For example, the batter who swings late may not be receiving the appropriate visual information due to difficiences in depth perception, visual acuity or some other visual attribute. While much emphasis has been placed on the latter stage of performance (overt movements), teachers and coaches have not generally assessed the individuals sensory (input) systems in an attempt to account for individual differences in motor performance or to provide additional

information about how to correct faulty performance. Since heavy demands are placed on the visual system of individuals during participation in movement tasks, especially fast moving ball games, it may prove beneficial for teachers and coaches to familiarize themselves with what the research says about visual attributes and skilled motor performance.

Visual Acuity

Dynamic visual acuity (DVA) is defined as one's ability to visually discriminate parts of an object (resolution acuity) when their is relative motion between the target and the performer (Burg & Hulbert, 1959). The research literature has suggested that this visual attribute may play a key role in motor task performance. Correlations as high as r = .76 have been found to exist between measures of DVA and basketball field goal shooting percentage during a competitive season (Beals, Mayyasi, Templeton & Johnson, 1971). Similar results have been reported by Morris and Kreighbaum (1977) who found that high percentage basketball field goal shooters showed less variability in selected DVA scores than a group of low percentage field goal shooters. Results from these investigations suggest that shooting from the field in basketball may be highly dependent upon DVA. Studies by Sanderson and Whiting (1974 & 1978) have also suggested a possible relationship between DVA and task performance. In their experiments the researchers found a significant relationship between DVA and performance on a ball catching task.

A more general review of the literature concerning DVA indicates that: (1) DVA follows a developmental trend in that children show marked improvement in this visual attribute between the ages of 5 and 12 (Morris, 1980), (2) there tends to be a positive relationship between DVA and one's performance on selected motor tasks, and (3) performance scores on DVA tests decrease as target speed increases (Sanderson & Whiting, 1974 & 1978).

Static visual acuity (SVA) or the ability to discriminate between parts of an object when both the target and performer are stationary has received much attention. The role of SVA in predicting basketball shooting ability was studied by Beal and others (1971). Their findings revealed a moderate relationship between SVA and both free throw shooting ($r = .59$) and shooting from the field ($r = .57$). However, several researchers (Sanderson & Whiting, 1974 & 1978) have found that SVA was not significantly correlated with either DVA or performance in a ball catching task. These findings are in general agreement with others (Burg, 1966; Warden, Brown & Ross, 1945) who have found that their is very little, if any, predictability of DVA from SVA scores.

Exercise and Visual Acuity. While the research dealing with the relationship between DVA and SVA on skilled motor performance is sketchy and fragmented, the effects of exercise on these two visual attributes is more conclusive. Of the studies reviewed for this article, all reported improved visual acuity following bouts of exercise. For example, Russian physiologist have reported as much as 45% improvement in visual acuity in 73% of the participants following a 1000 m race (Graybiel, Jokl & Trapp, 1955). Vlahor has also noted improved visual acuity following both bicycle ergometer exercise bouts (1977a) and participation in the Harvard Step Test (1977b). Even participation in the recreational activity of table tennis for a duration of only 10-minutes has been found to temporarily improve visual acuity (Whiting & Sanderson, 1972). These reported improvements in visual acuity have lasted as long as 2-hours following the succession of exercise (Graybiel, Jokl & Trapp, 1955).

Depth Perception

The difference existing between the two images on the eye's retina's is a primary cue used by the central nervous system to judge depth (binocular

disparity). Without doubt, the accurate judgement of depth is an important visual attribute for skilled motor performance. Nevertheless the research literature presents conflicting viewpoints as to the relationship between depth perception and sporting success. Attempts at correlating measures of depth perception with both basketball shooting from the field (Beals, Mayyasi, Templeton & Johnston, 1971; r = .56: Shick, 1971) and free throw line (Beals, Mayyasi, Templeton & Johnston, 1971; r = .09) have not been highly successful. While earlier studies have reported that 30 tennis players perceived depth better than 122 football players and that the more skillful athlete perceived depth better than the average athlete (Graybiel, Jokl & Trapp, 1955). From these findings one can speculate that the necessarity of an accurate depth perception system is task specific. In addition, it is likely that secondary cues (shadows, ball texture, projectile size) may be utilized by the central nervous system to perceive depth. This hypothesis may explain how some athletics maintain a high level of performance without the aid of stereo vision. From a developmental point of view it appears that the ability to perceive depth improves with age (Morris, 1980) and is well established by age twelve (Williams, 1967 & 1968). While males have been found to obtain fewer discrimination errors than females on measures of dynamic depth perception (Weissman & Slonim, 1973) it appears that training narrows these differences (Slonim, Weissman, Glazer & Nettler, 1975).

Field of Vision (Peripheral Vision)

Performers in some sport activities rely upon peripheral vision to deceive opponents. Without doubt basketball is one activity where an increased field of vision appears to be an asset. It is generally agreed that a ball handler must utilize peripheral vision to avoid the mistake of "telegraphing" the pass. This assumption is supported by the works of

Hobson and Henderson (1941) who found that a group of proficient basketball passers had horizontal visual field perception 15° greater than other ball players. Furthermore, the team's two best shooters were found to have a vertical visual field of 10° greater than normal. However, some research indicates that there is no difference in basketball shooting performance when comparing normal rim sighting to sighting 10° from the basket (Sills & Troutman, 1965).

The importance of peripheral vision to skilled motor performance is probably best shown by a group of studies reported by Graybiel and others (1955). Central and peripheral vision was systematically occluded during performance in various track and field events as well as performance in gymnastic and sking events. In all cases the championship athletes reported that the elimination of peripheral vision affected performance more than the exclusion of central vision. Common complaints included, a loss of precision and timing, difficulty in judging distances, and clumsiness of movements. It appears that skills carried out at high speeds requires the performer to rely upon peripheral vision for essential spatial orientation cues (Graybiel, Jokl & Trapp, 1955). Peripheral vision training and exposure to activities requiring peripheral vision may improve this visual attribute (Johnson, 1952).

Comparing Visual Attributes of Athletes and Non-Athletes

Since training and exposure to sport activities tends to improve visual attributes, one would expect athletes to possess a more efficient visual system than non-athletes. This hypothesis is in part supported by Williams and Thirer (1975) who's work demonstrated that both vertical and horizontal field of vision were superior in the athlete as compared to the non-athlete. Such visually related qualities as far point lateral imbalance, directed timing, choice timing, simultaneous vision and steropsis have been found to

differentiate between successful college varsity baseball players, rejected candidates and non-athletes (Winograd, 1942). Up to this point, differences between athletes and non-athletes on visual attributes have been explained by both physiological and psychological means. However, it appears the athletes ability to judge depth may be related to an anatomical phenomenon. Interpupillary distance (IPD), or the distance between the two eyes has been found to be a factor in one's ability to judge depth. The greater the distance between the two eyes, the greater the disparity between the images on the retinas of the eyes. As pointed out earlier, binocular disparity is used by the central nervous system to judge distance. A classical study conducted in 1931 (Bannister & Blackburn) demonstrated that IPD could be utilized to distinguish between poor and good ball players. They concluded that, "interpupillary distance is a factor which affects depth perception to a sufficient degree to influence a man's success in sports which involve batting and throwing balls" (Clark & Warren, 1935).

Summary and Implications

A review of the literature indicates that visual attributes contribute to the learning and performance of motor skills. While males tend to be superior to females; and athletes superior to non-athletes in many visual abilities, visual training tends to narrow these differences. Thus exposure to visual-perceptual activities may improve skilled motor performance.

Knowledge concerning the visual abilities of athletics and other individuals attempting to learn motor skills may provide the teacher and/or coach with predictive power. Treating visual attributes as an independent variable, researchers have been able to utilize statistical techniques (multiple regression) to predict future performance. For example, Beals and others (1971) were able to predict basketball shooting performance with 96% confidence by substituting visual attribute scores into the following equations:

Predicted Field Shooting Average = 20.14 + 18.64 (SVA) + 0.88 (DP) + 0.11 (DVA)

Predicted Free Throw Average = 43.75 + 56.17(SVA) +
1.22(DP) + 0.26(DVA)

Teachers do not generally require warm-ups before teaching such fundamental skills as catching or basketball shooting. Physiological warm-up is usually thought of as a waste of class instructional time if the skills being taught are passive in nature. Perhaps the improved visual capabilities following bouts of exercise warrents the use of warm-ups before participating in selected ocular-motor skills, even if the skills are not bolistic in nature.

Information obtained from visual screening may help teachers and coaches identify causes of poor motor performance. For example, players with poor peripheral vision do not generally guard the offensive player close enough. They must "drop-off" their man in order to get a better view of the playing area. Such a practice is likely to lead to poor defensive performance. Once the causes of poor performance have been identified, corrective measures may be taken.

In order to predict future performance, provide better individualized instruction, and find better means of correcting faulty performance, teachers and coaches must be aware of the many internal and external factors which affect performance. Because of the heavy demands placed on the visual system of performers it is suggested that visual screening play a greater role toward these ends.

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